THE PAST AND FUTURE OF CO_2 EOR FLOODING

A Brief History and Summary of the Industry's Experience plus a Look Forward to Tomorrow's Promise and the Evolving Commercial Drivers

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For the USDOE/PTTC CO_2 EOR Workshop and Solicitation Announcement in Houston

February 22, 2006

PTTC TECHNOLOGY CONNECTIONS

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THE PAST AND FUTURE OF CO_2 EOR FLOODING (1)

- EMERGENCE AND MATURATION OF CO_2 FLOODING TECHNOLOGY AND DEVELOPMENT OF BEST PRACTICES
- BEING LED INCREASINGLY BY INDEPENDENTS AND NOW SPREADING TO AN UNCONVENTIONAL PHASE (IMMISCIBLEs, VERTICALs, ROZs, etc.)
- NEW FLOODING MILESTONES REACHED
- ALL GEOGRAPHICAL AREAS ENTERING A NEW PHASE – CO_2 SHORT AND NEW INFRASTRUCTURE BUILDOUT

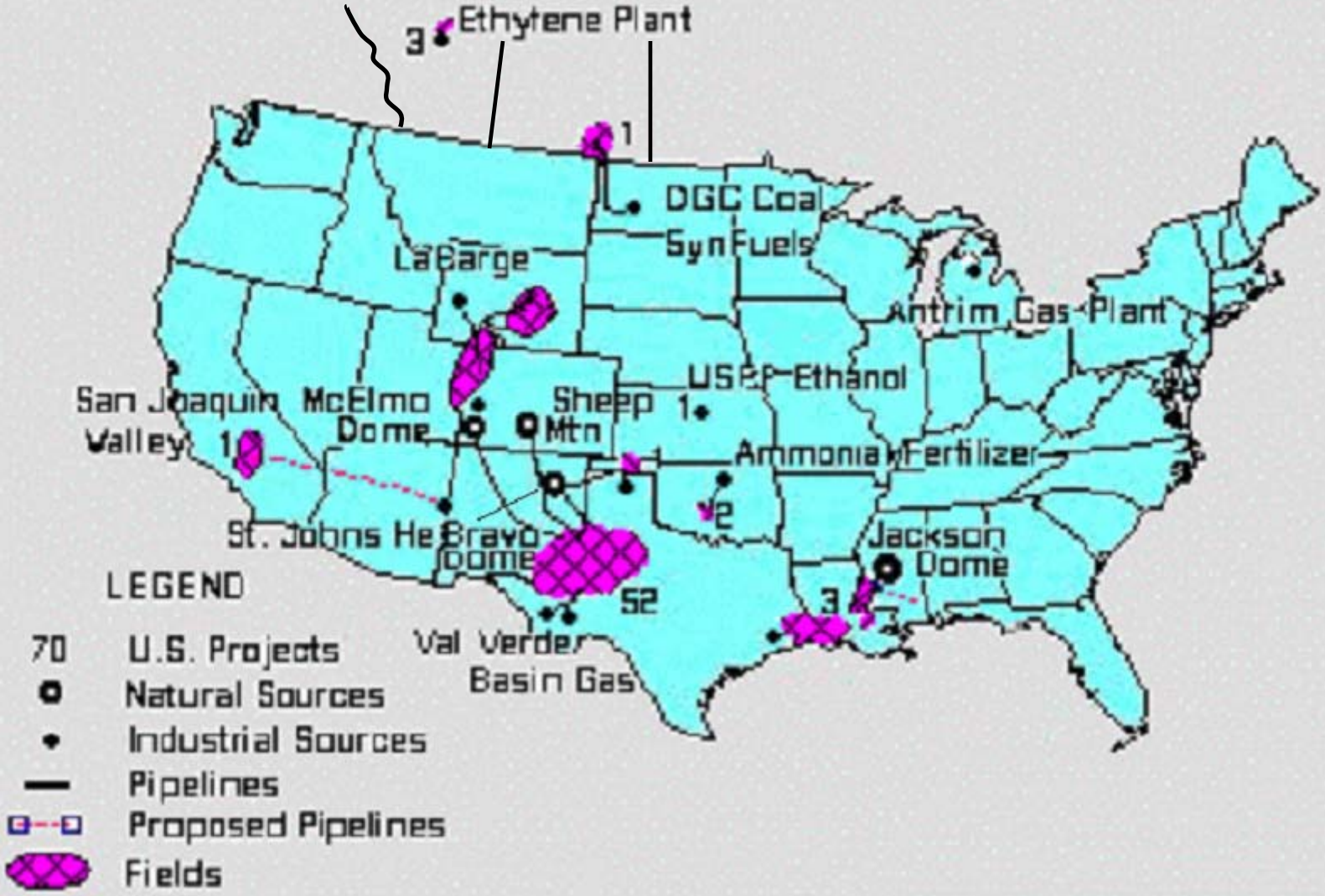
THE PAST AND FUTURE OF CO_2 EOR FLOODING (2)

- NEW BUSINESS DRIVERS
  - OIL PRICING
  - CONCERNS OVER INDUSTRIAL CO_2 EMISSIONS
- POTENTIAL CO_2 EOR RESERVOIRS WILL HAVE ADDED VALUE
- TREMENDOUS FLOODING GROWTH OPPORTUNITIES
- HELP NEEDED
  - FROM CAPITAL MARKETS AND STATES (INFRASTRUCTURE BUILDOUTS)
  - FROM RESEARCH

WORLDWIDE (WW) CO_2 FLOODING

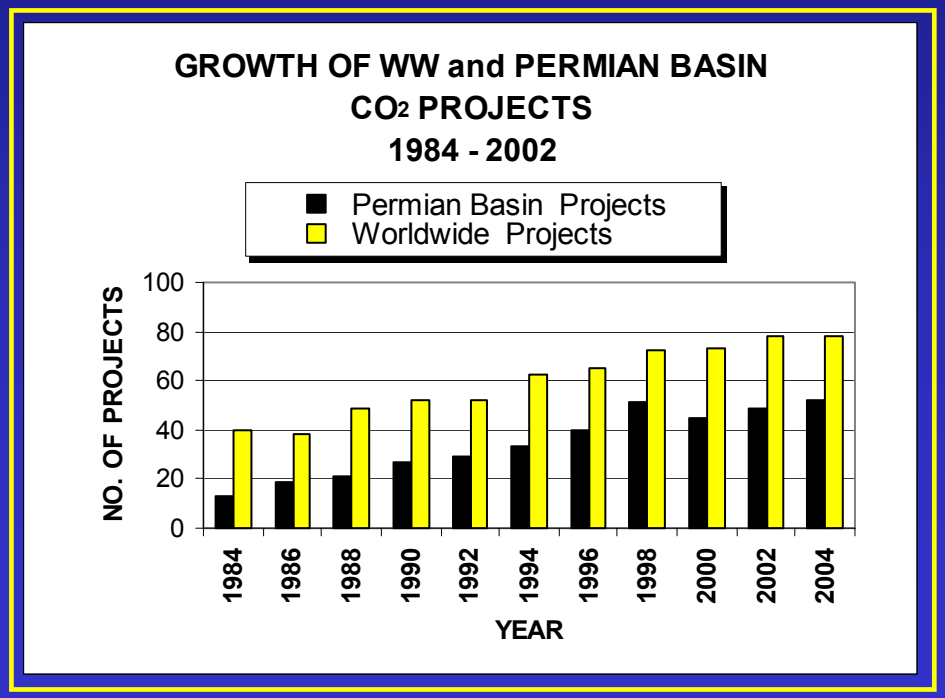
- First Large-scale Demonstrations in West Texas in the Early 70's
- Since Then, Projects Implemented in Many States
  - Arkansas, California, Colorado, Kansas, Kentucky, Louisiana, Michigan, Mississippi, New Mexico, Pennsylvania, Oklahoma, Utah, West Virginia, Wyoming
  - New Opportunities Being Studied There and in Alabama, Florida, Illinois, Indiana, Ohio, North Dakota, Montana
- Through the 30+ -year History, CO_2 Flooding has had Steady Growth To the Present Day

North American CO_2 Floods and Flood Infrastructure



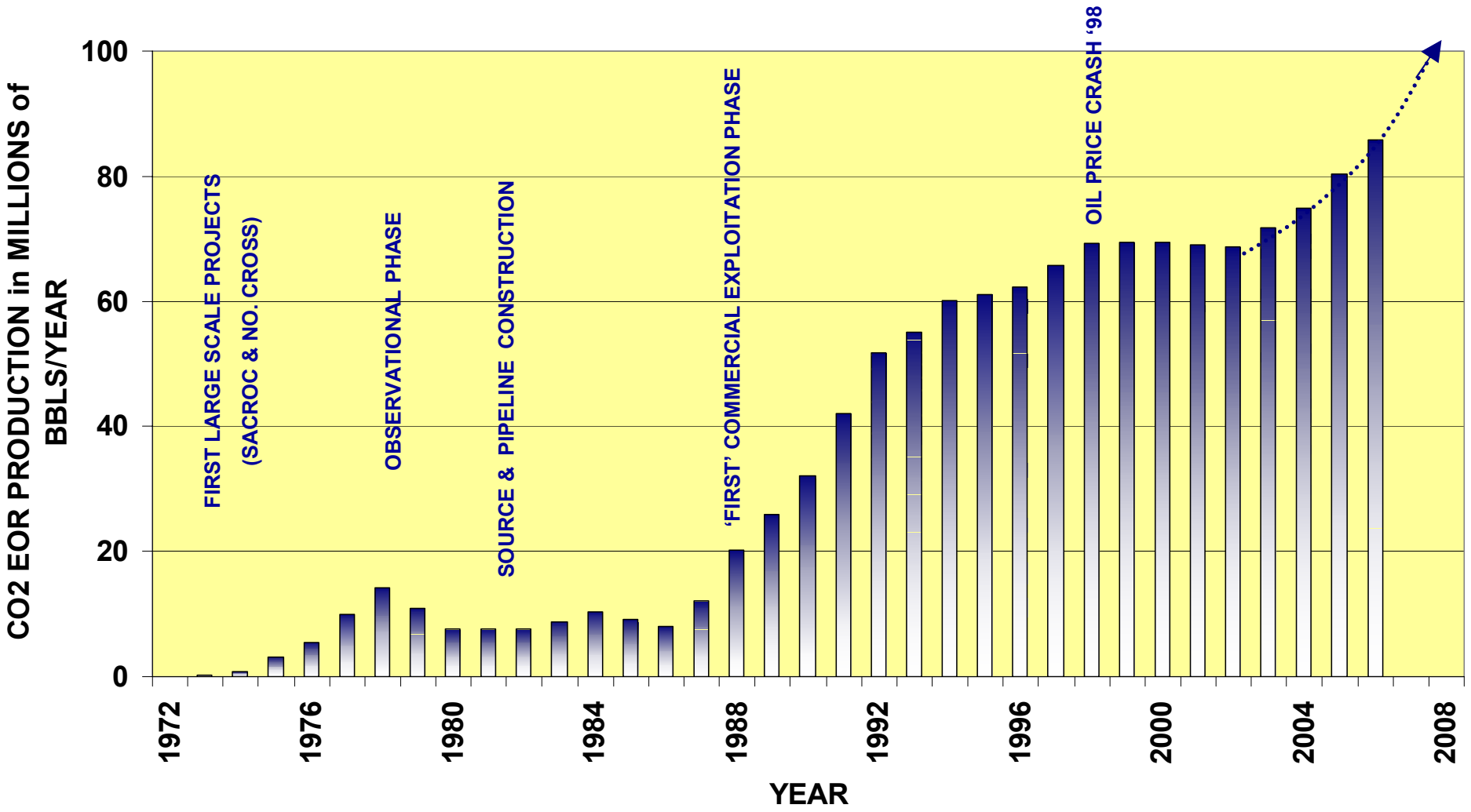
ACTIVE FLOODS
(as of Jan '04)

- 75 TOTAL (71 MISCIBLES)
- 69 U.S.
- 50 PERMIAN BASIN



WORLD WIDE	ACTUAL
TOTAL ACTIVE FLOODS	75
TOTAL FLOODED ACRES	303,115
NO. OF PRODUCERS	6,488
NO. OF INJECTORS	3,870
TOT PRODUCTION (BPD)	290,840
ENHANCED PROD (BPD)	212,167

U.S. CO_2 EOR PRODUCTION - FROM 1972 Thru DEC '05*



* Data Derived from Oil & Gas Journal and UTPB Petroleum Industry Alliance

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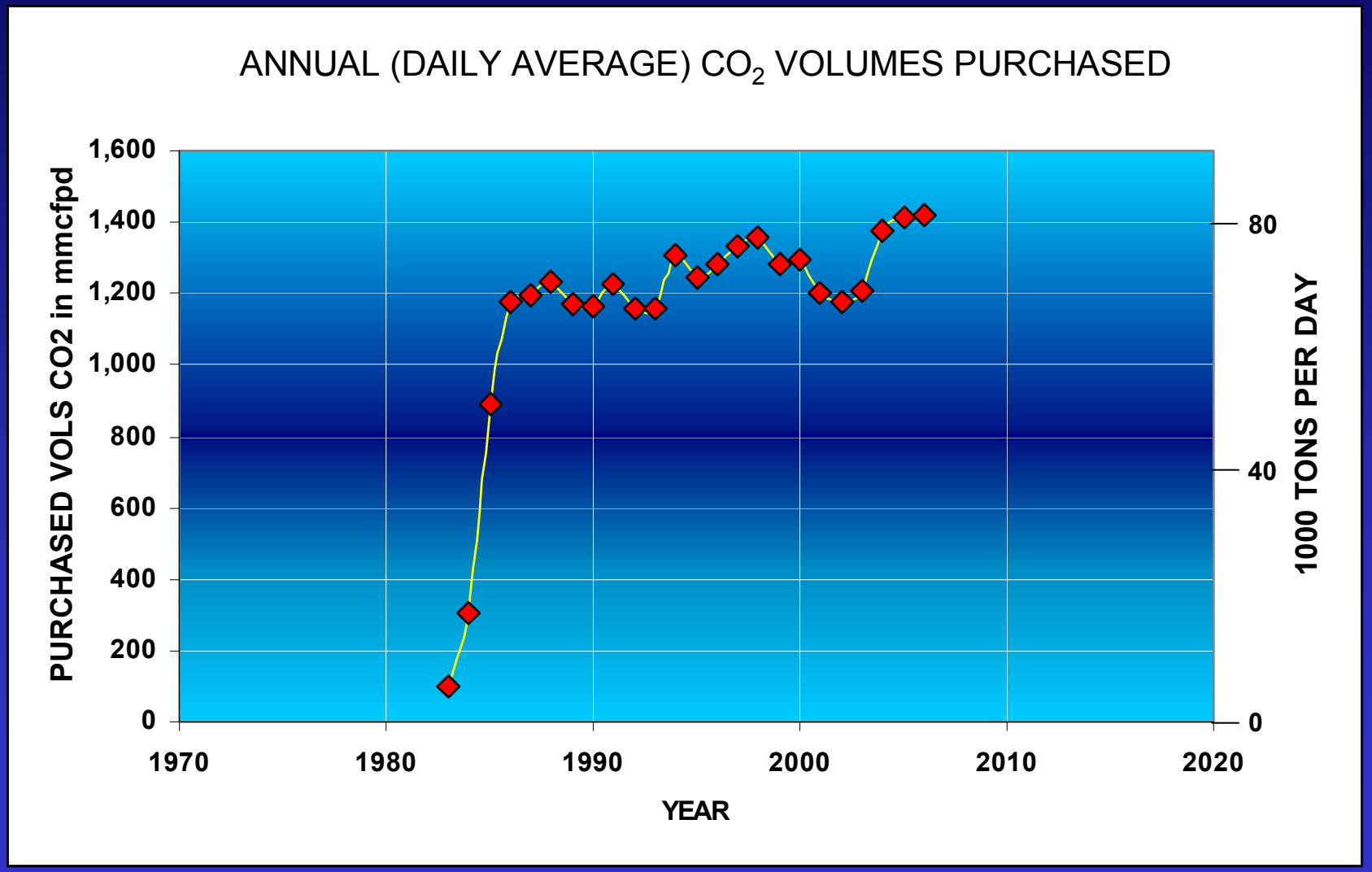
GROWING CO_2 VOLUMES (PERMIAN BASIN)



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Conventional CO_2 EOR (Circa 2005)

- Dominated by Pattern Flooding of Carbonate Shelf Dolomites and Aeolian Origin Sandstones
- Flood Maturity at HCPV Slugs of 0.4-0.6
- Underground Natural Sources of CO_2 with Delivered Costs of $10-20/ton

Let's call this "Conventional EOR Oil"

There is still a lot of this to do but…….

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CO_2 and Unconventional Oil

- **Heightened Concerns over GHG Emissions**
- **Coming Incentives for Reduced Emissions, e.g…..**
  - **a la EU Trading Credits**
  - **Tax Credits**
  - **Loan Guarantees**
  - **Gov't Backed Bonds**

Effect: CO_2 Less Expensive

- **CO_2 EOR's "Least Cost" Alternative**

Effect: New Benchmark for Flood Economics

- **CO_2 EOR's Bridge to the Regulatory Management of Geologic Sequestration of CO_2**
- **The Coming Ubiquitous Sources of CO_2**

Effect: Removes CO_2 "Access" Obstacle

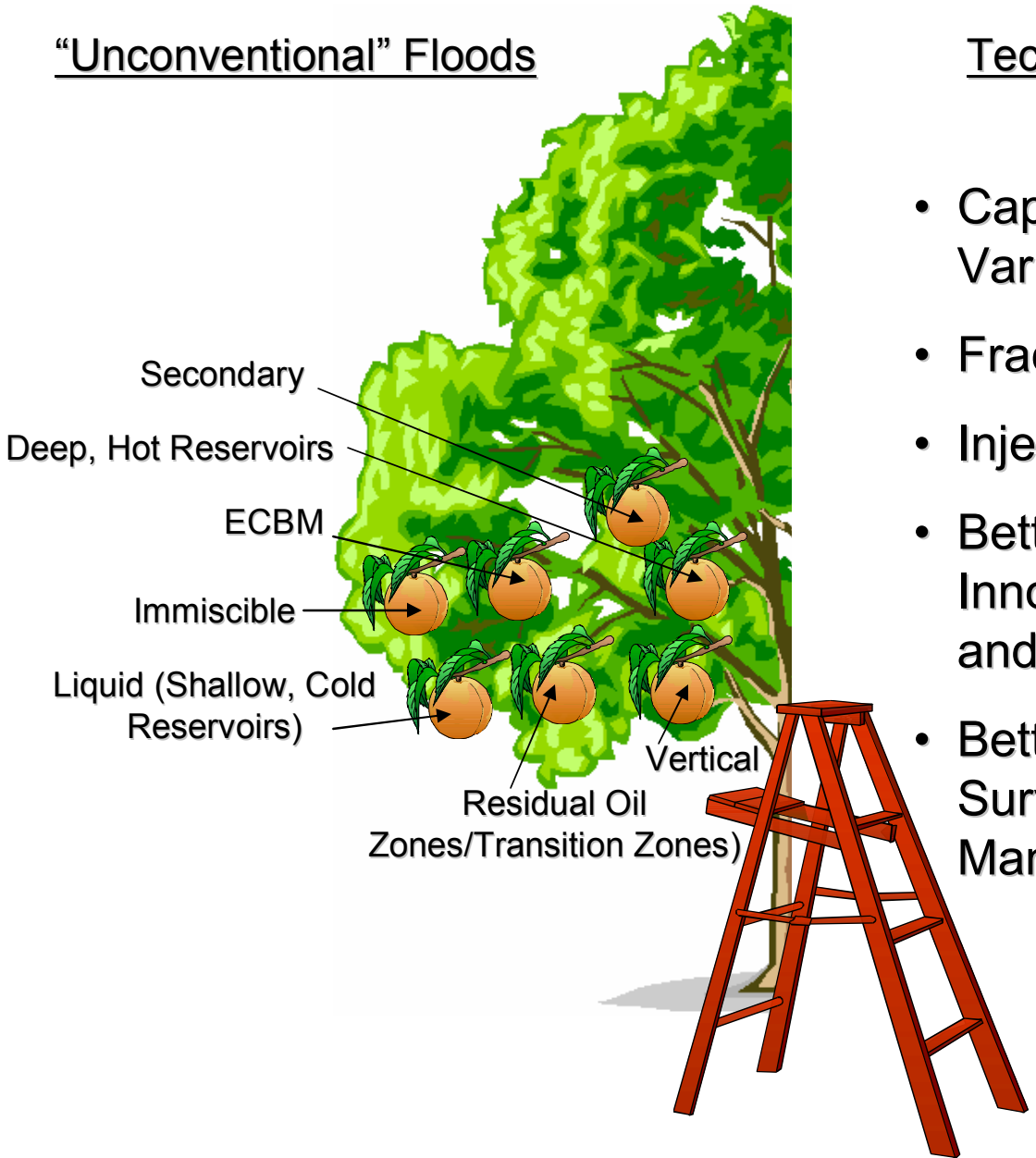
- **Build-out of CO_2 Capture and Transportation Infrastructure**

THE CURRENT CO_2 FLOODING PLAYERS

Amerada Hess	Fasken
Anadarko	Kinder Morgan
Apache	Merit Energy
Apache Canada	Murfin Drilling
Chaparral Energy	Orla Petco
ChevronTexaco	Oxy Permian
ConocoPhillips	PennWest Energy
Core Energy	Stanberry Oil
Denbury Resources	Unocal
EnCana	Whiting Petroleum
Energen	XTO Energy
ExxonMobil	

The Unconventional CO_2 Flooding Tree (1)

"Unconventional" Floods



Technology Challenges

- Capability to Handle Variable Perm Profiles
- Fracture Management
- Injection Additives
- Better Sweep thru Innovative Flood Design and Well Placement
- Better Reservoir Surveillance and Management

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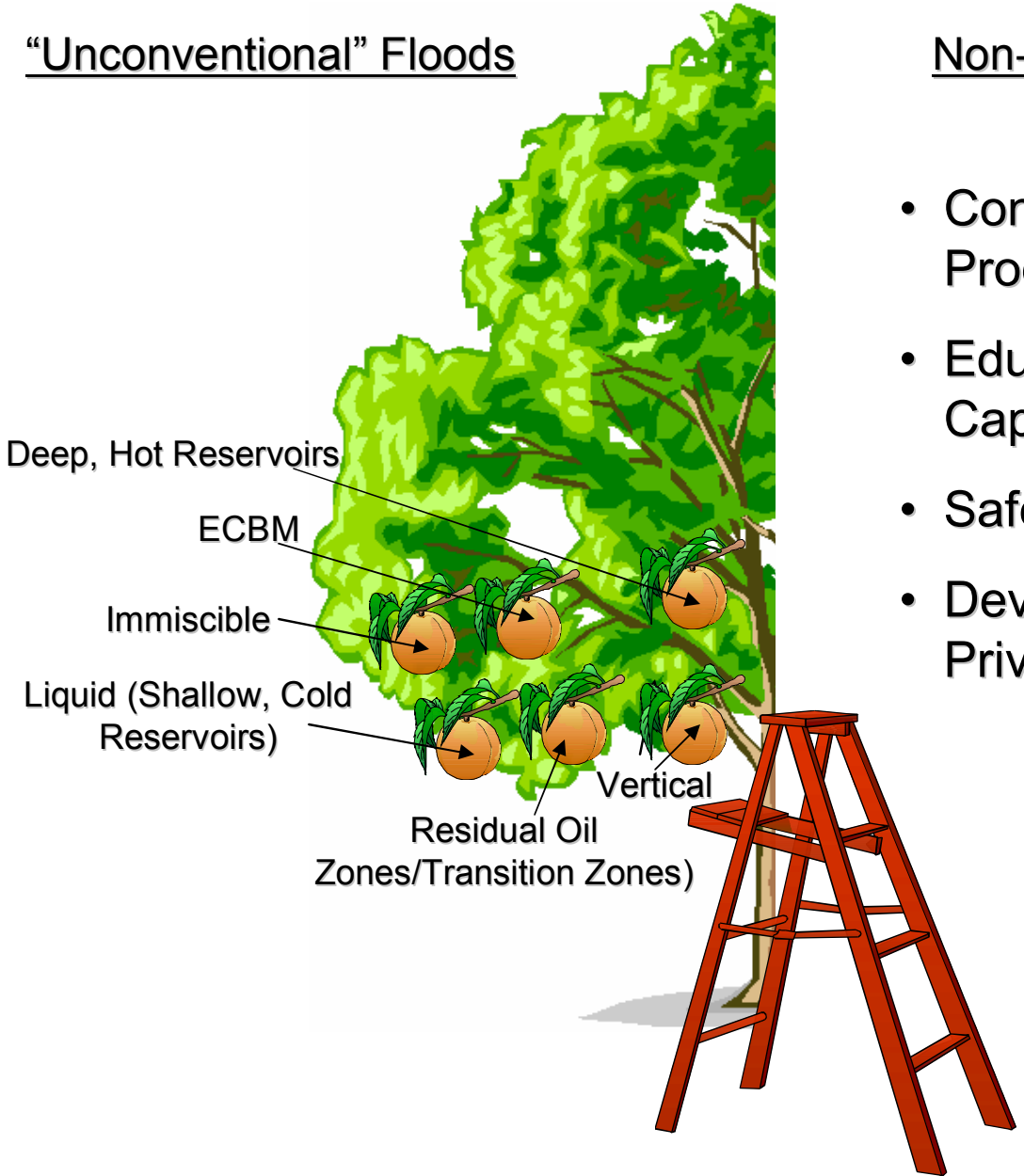
The Unconventional CO_2 Flooding Tree (2)

"Unconventional" Floods



Non-Technical Challenges

- Consolidating Discrete Producing Areas
- Educating/Finding/Training Capable Personnel
- Safety and Regulatory
- Developing the Public-Private Partnership

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THE COMING NEW PHASE OF CO_2

REQUIRES AN INTERPLAY OF:

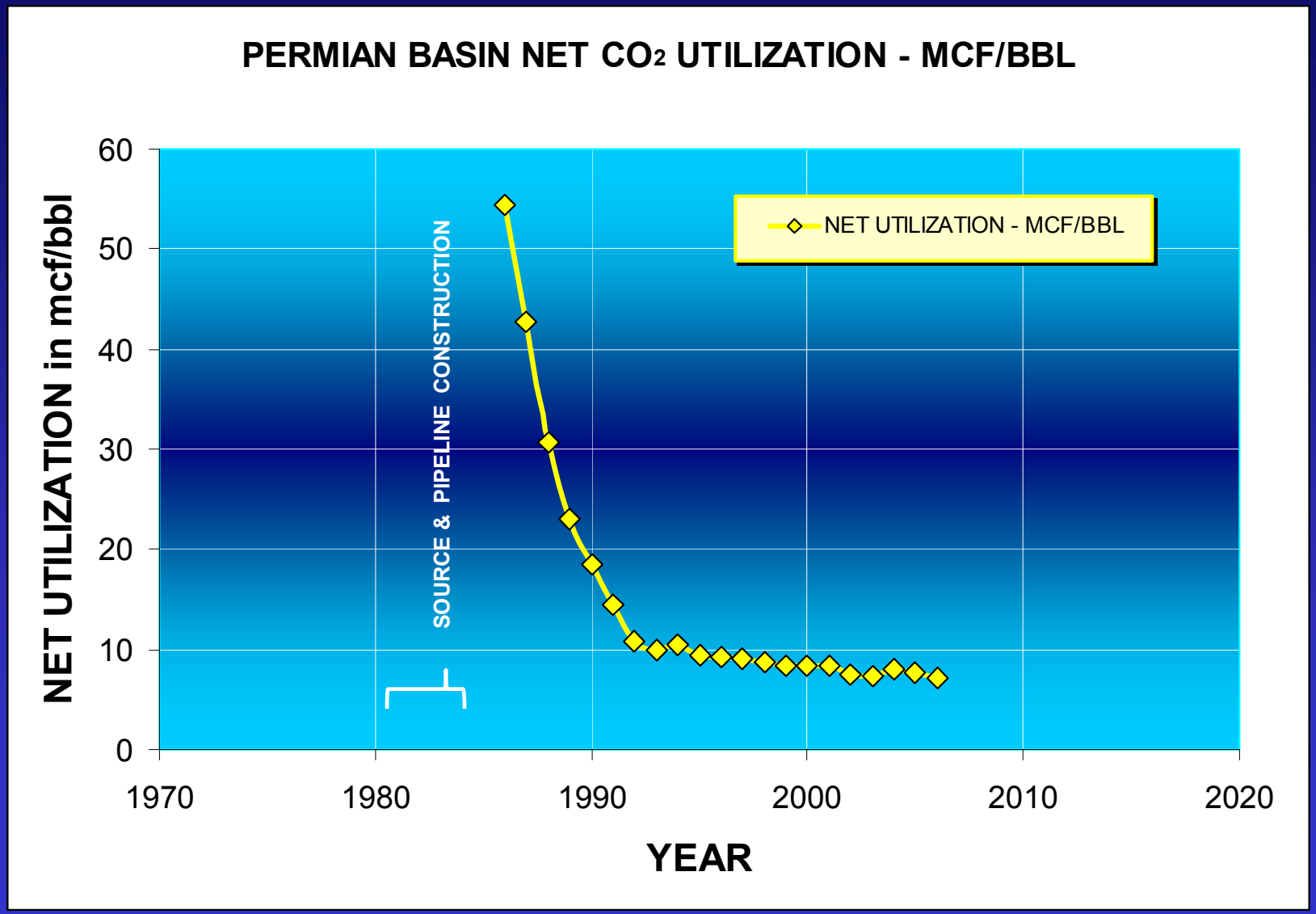
1) CONTINUED TECHNOLOGY TRANSFER OF CONVENTIONAL CO_2 FLOODING

2) ADVANCEMENT OF TECHNOLOGY FOR UNCONVENTIONAL CO_2 FLOODING

3) EXPANSION AND UTILIZATION OF THE NEW SOURCES OF CO_2

INFRASTRUCTURE BUILDOUT

CASE HISTORY



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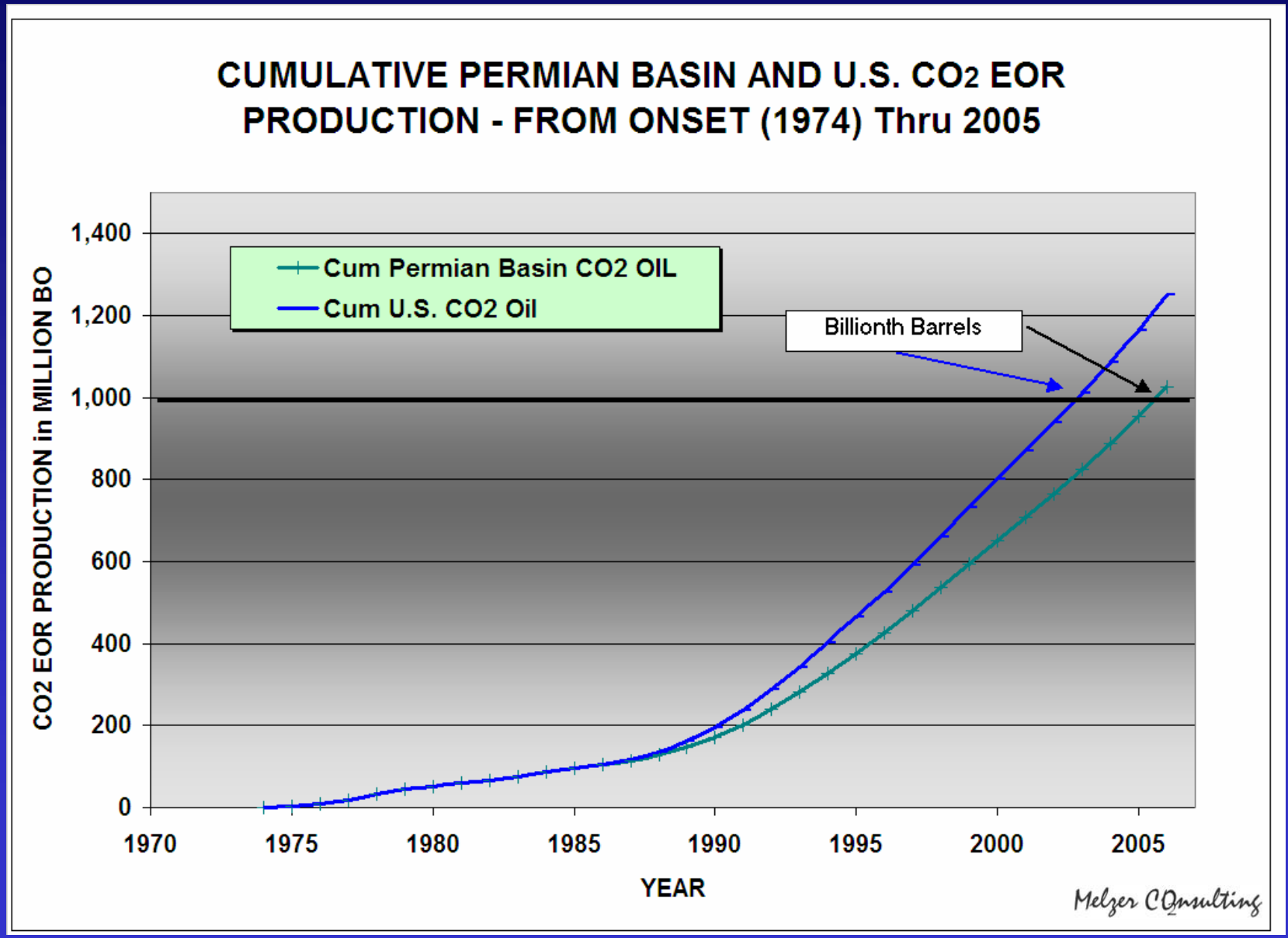
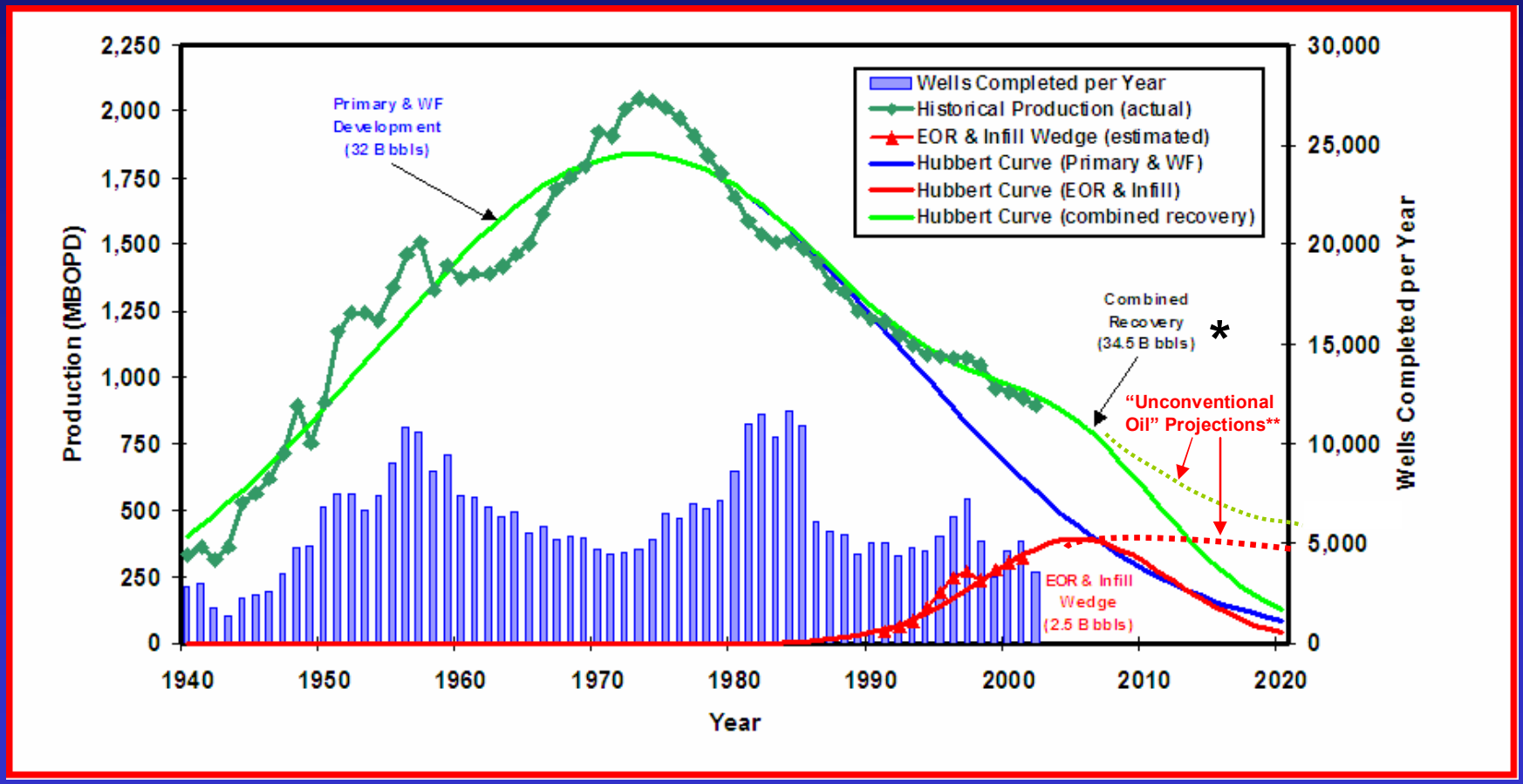
AN IMPRESSIVE SET OF CO_2 EOR PERFORMANCE MILESTONES

The Billionth Barrels of CO_2 Flooding



PERMIAN BASIN OIL PRODUCTION

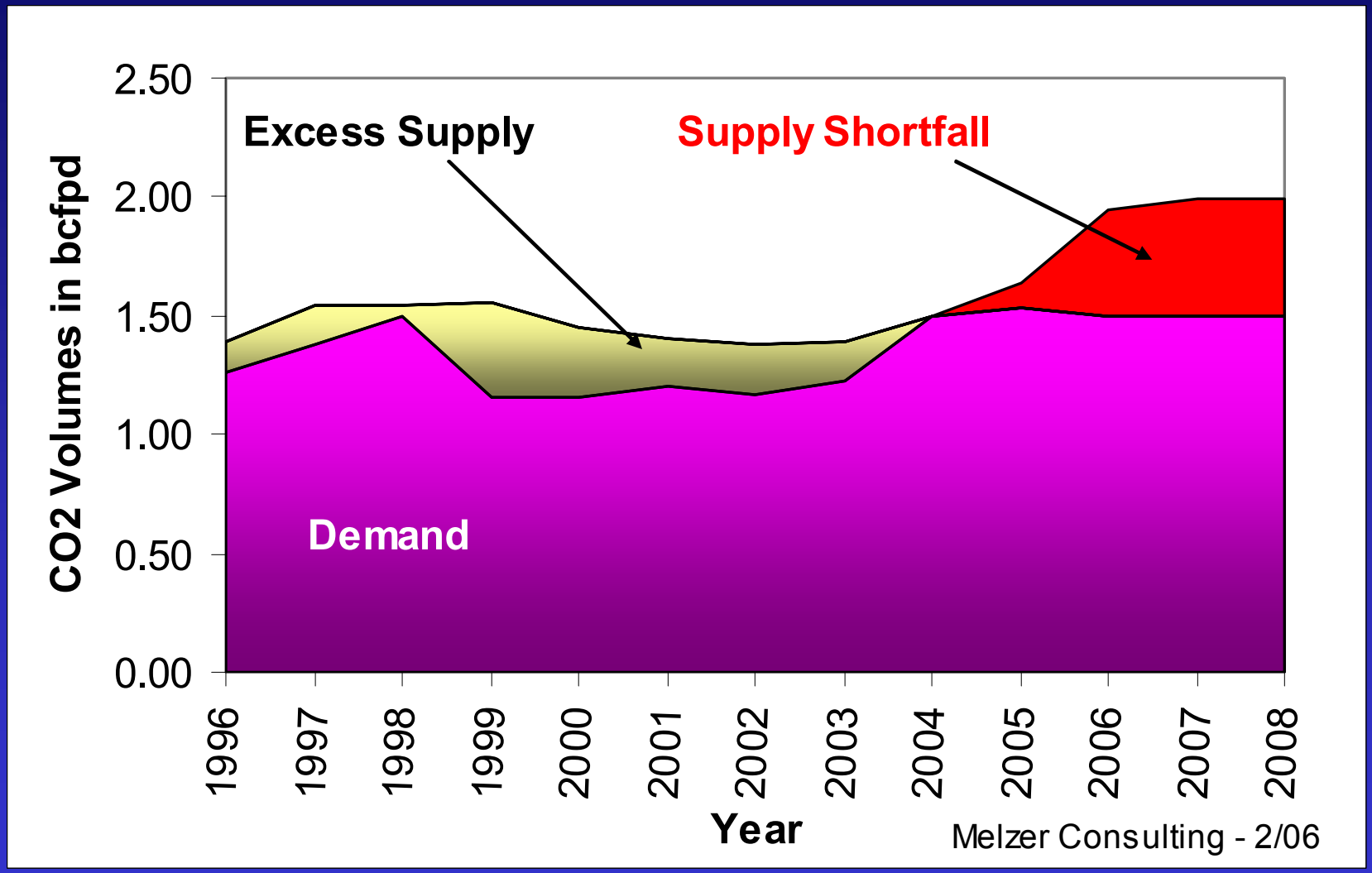
PRIMARY, SECONDARY, TERTIARY AND "UNCONVENTIONAL OIL" PROJECTIONS



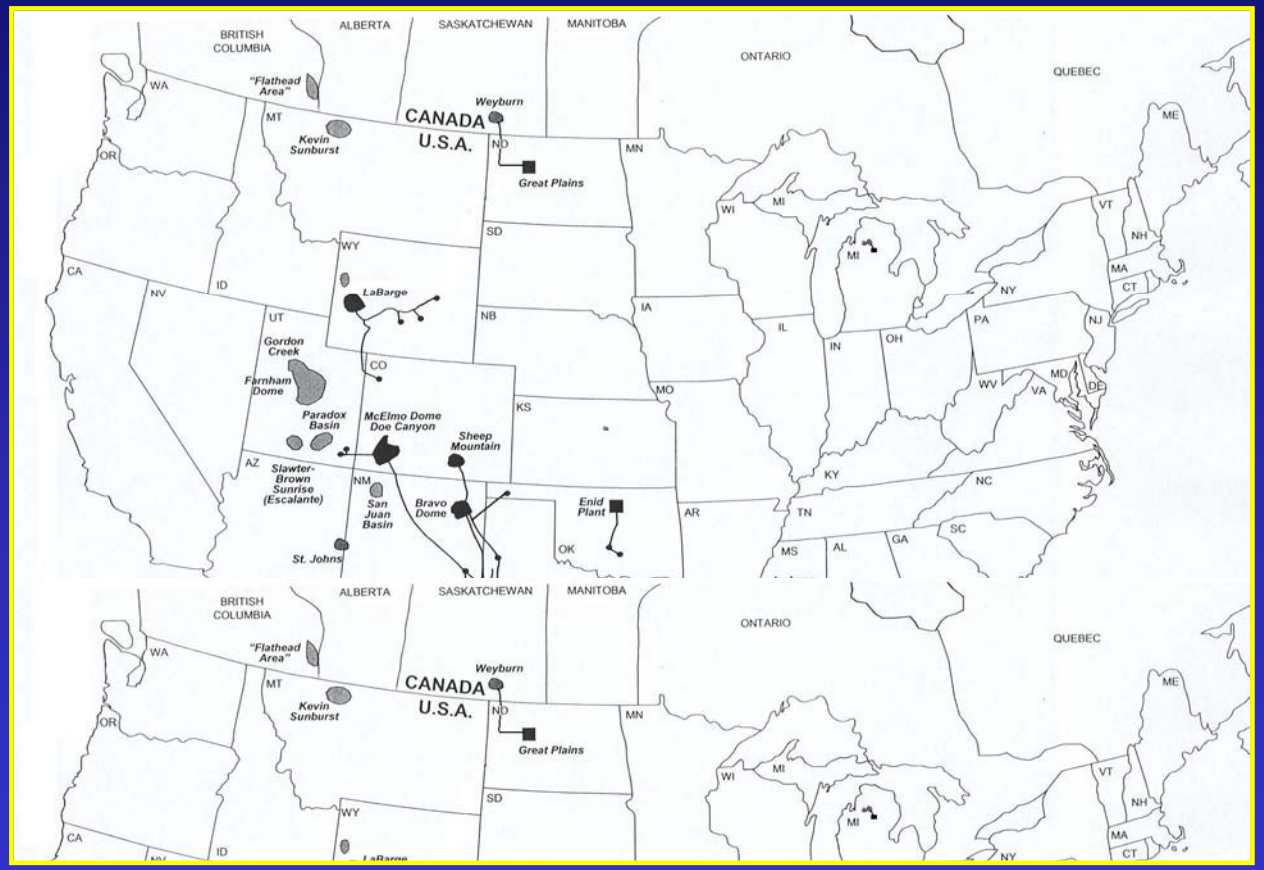
* Courtesy of Oxy Permian (9/05)

** "Unconventional Oil Projections Using No New CO_2 Sources" Melzer Consulting 2005

PLENTY OF OPPORTUNITY
BUT WHERE WILL THE CO_2 SUPPLY COME FROM?



CO_2 SOURCES AND TRANSPORTATION

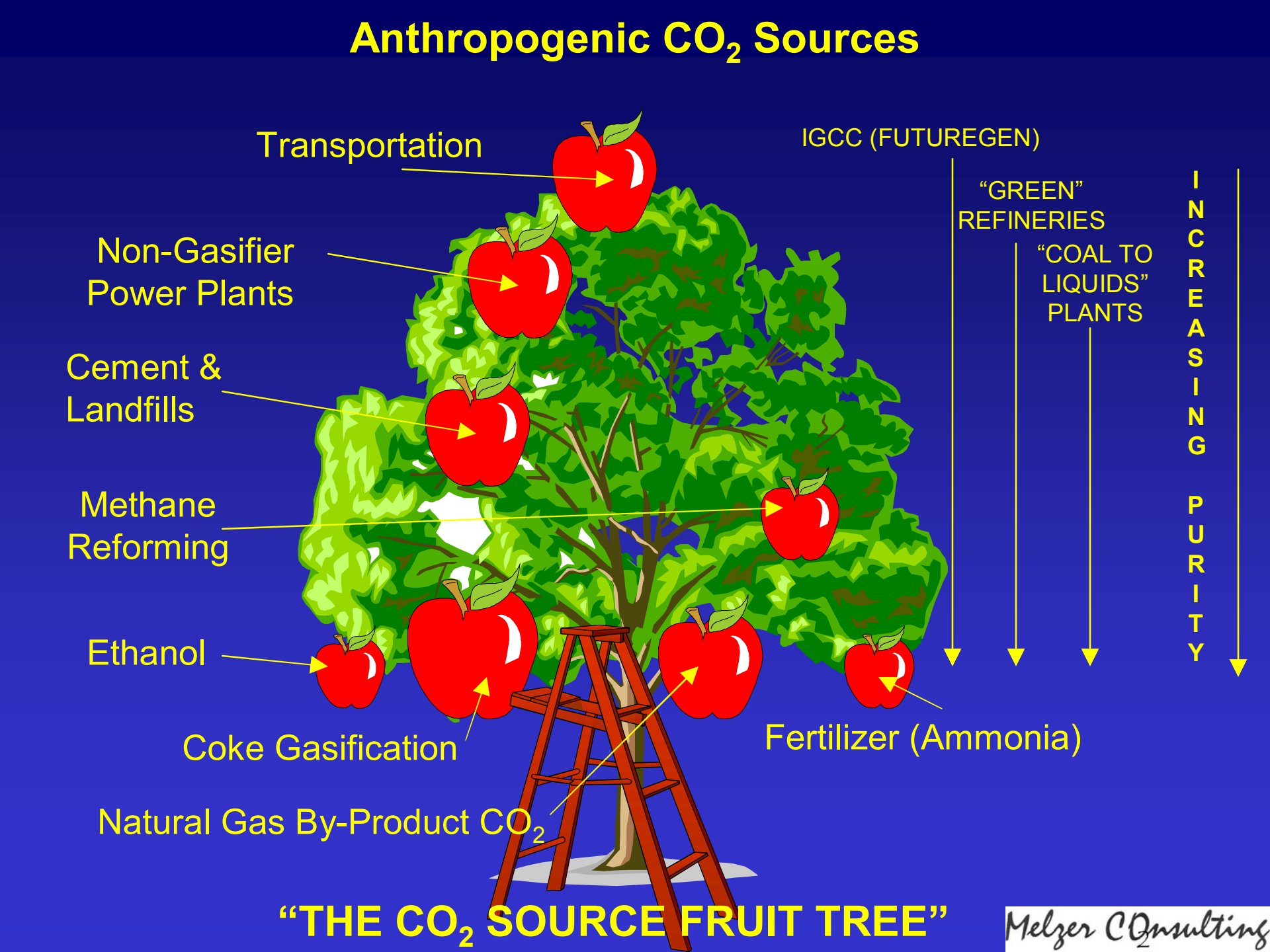


SOURCING:

1) NATURAL UNDERGROUND
2) INDUSTRIAL OR ANTHROPOGENIC

THE COMNG WAVE

Anthropogenic CO_2 Sources



"THE CO_2 SOURCE FRUIT TREE"

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THE COMING "UNCONVENTIONAL OIL" PHASE

- **CONTINUING MATURITY OF OILFIELDS**
- **ADVANCEMENTS IN CO_2 EOR TECHNOLOGY**
- **PROFILERATION OF ANTHROPOGENIC CO_2 SOURCES**

NEAR TERM – **MORE EXPLOITATION OF LOW BTU (CO_2 LADEN) NATURAL GAS w/ CO_2 CAPTURE)**

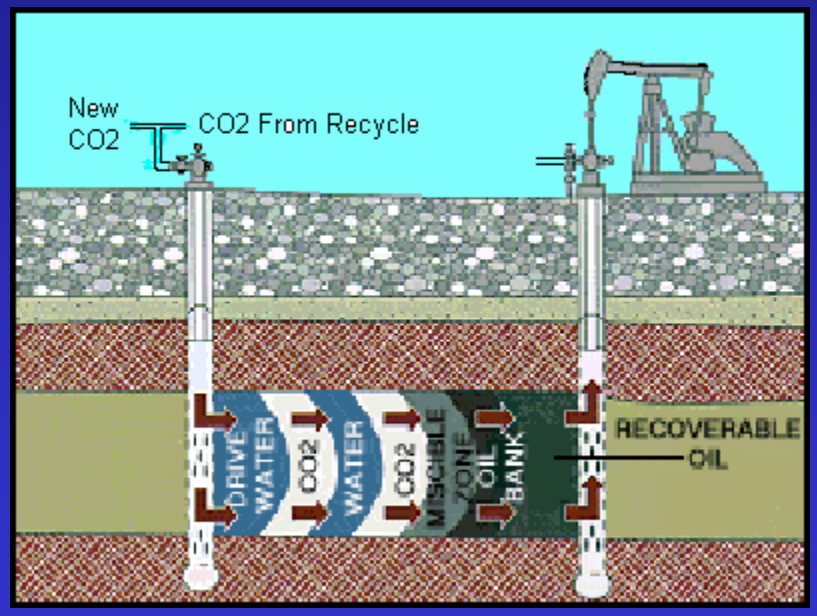
SOME NEAR, MOSTLY MID TERM – **CAPTURE OF INDUSTRIAL CO_2 SOURCES (CEMENT, HYDROGEN, HELIUM, ETHANOL ETC.)**

LONG TERM? BIG VOLUMES – **ONSET OF IGCC POWER PLANTS w/ CO_2 CAPTURE**

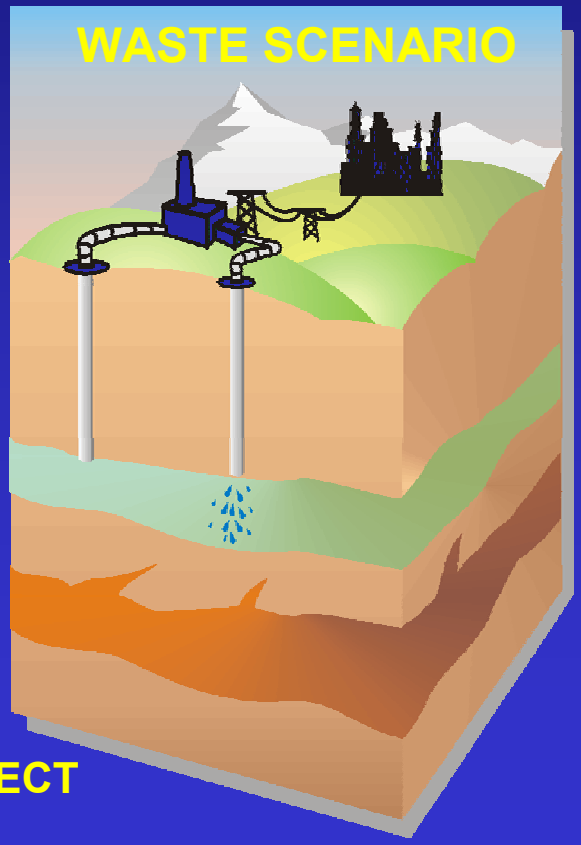
COMMODITY VS. WASTE CO_2

- THE OIL INDUSTRY CAN HANDLE (AND SEQUESTER) HUGE VOLUMES OF BY-PRODUCT CO_2 FROM INDUSTRIAL SOURCES
- WASTE INJECTION IS BURDENSOME TO CONSUMERS OR RATE PAYERS

COMMERCIAL CO_2 EOR



WASTE SCENARIO



BENCHMARK FOR CO_2 EOR: IS IT SIMPLY PROJECT ROR OR IS IT REALLY WASTE INJECTION?

CAN THE OIL INDUSTRY DO THIS ALONE?

- MAJORS ARE NOT HERE TO PUSH THE TECHNOLOGY ENVELOPE
- INDEPENDENTS DO NOT HAVE LARGE BUDGETS FOR INNOVATIVE APPROACHES AND UNCONVENTIONAL FLOODING
- LOTS OF CAPITAL REQUIRED: SOURCE, PIPELINES, PLANTS, CO_2 FLOODS: OIL INDUSTRY NEEDS HELP
- RECOGNITION OF THE SHORTAGE OF TECHNICAL PERSONNEL

CO_2 FLOODING SUMMARY (1)

- PROVEN TO BE TECHNICALLY AND, UNDER MANY CIRCUMSTANCES, ECONOMICALLY ATTRACTIVE
- EXPANDING TO UNDEVELOPED AREAS AND UNCONVENTIONAL (MORE TECHNICALLY RISKY) RESERVOIRS
  - VERTICAL
  - ROZ's
  - IMMISCIBLES
  - DEEP, HOT
  - SECONDARY
  - LIQUID, COLD
- COMMERCIAL DRIVERS HAVE CHANGED; COMING CO_2 ABUNDANCE, OIL PRICING

CO_2 FLOODING SUMMARY (2)

- BENCHMARK IS CHANGING:
  - PAST: COMMERCIAL RATE OF RETURN VS.
  - FUTURE: WASTE INJECTION
- DRAMATIC FLOODING GROWTH EXPECTED AS (INDUSTRIAL) SOURCES OF CO_2 PROLIFERATE

CO_2 SEQUESTRATION AND EMISSIONS TRADING AS A DRIVER

As per the EOR Carbon Management Workshop

December 2005

Midland, Texas

EOR Carbon Management Workshop Recap

Michael Moore

Workshop Director

December 8, 2005
Midland, Texas

Recent Events

- EU ETS trading at ~$25.00 US /ton
- Congressman Bingaman—Cap and Trade by 2008 announced at COP/MOP
- Canada declares CO_2 a pollutant
- New Jersey declares CO_2 a Pollutant
- Mitsubishi present Geologic Sequestration CDM Project for review
- Indications of at least 17 gasification projects in various stages in US
- OPEC to utilize CO_2 EOR + Sequestration in forward strategy
- Peak Oil debate picks up steam—looking at “Energy Wedge”
- IPCC Special Report on CCS-supports implementing
- California contemplating requiring imported power to have a minimal CO_2 footprint
- Norwegian Government changes-more supportive of CCS
- FutureGen Consortium finalized and accepted--regional competition in full swing
- Western Governor’s Association Draft on GHG issues--CCS in review
- Canada Developing Cap and Trade Program-uncertain Government until after elections CCS has major role
- WRI Initiates CCS Protocols
- BP-Scottish Power-Miller Field initiates first North Sea CCS with EOR

Two Markets for Same Molecule

- **Commodity CO_2 for use in Enhanced Oil Recovery in the US and Globally-$+30/ton**
  West Texas, Wyoming, North Dakota/ Saskatchewan at maximum delivery capacity

- **Kyoto inspired Greenhouse Gas reductions and resulting tradable offsets..+25.00/ton**
  Last three months of 2005 saw $1 billion turnover each month. Market did not exist 12 months earlier…

- **EU ETS and other markets waiting for protocols that are being developed for geologic sequestration**

ARI (Kuuskraa) SUMMARY

Original Oil In-Place: 582 B Barrels

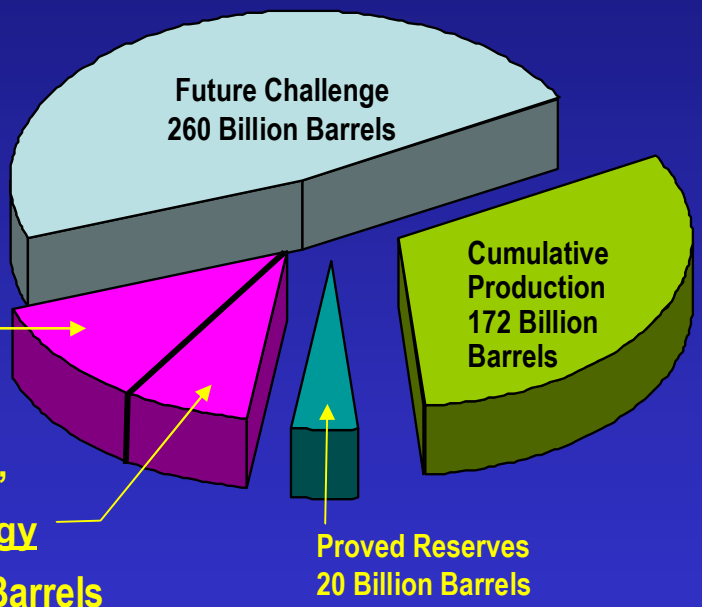
"Stranded" Oil In-Place: 390 B Barrels

"State-of-the-Art" CO_2-EOR Technology

- **43 Billion Barrels** (Six Basin/Areas)
- **89 Billion Barrels** (Ten Basins/Areas)

"Next Generation" CO_2-EOR Technology

- **40 Billion Additional Barrels** (Six Basins/Areas Studied to Date)



- **The overall CO_2-EOR "prize" is large, at 89 to 129 billion barrels, technically recoverable.**
- **With progress in CO_2-EOR technology, this prize can become "real", providing 47 billion barrels of economically recoverable domestic oil.***
- **"Next Generation" advances in technology would significantly increase the size and economic potential of using CO_2-EOR.**

**Assumes $40/B oil price and low cost ($0.80/Mcf) CO2 supplies (Scenario #4).*
Source: NPC Public Data Base, updated by Advanced Resources Int'l. (2005), for all domestic basins except the Appalachian Basin.

THE “PRIZE” IS LARGE….

…AND TODAY’S BEST PRACTICES ARE THE BUILDING BLOCKS